HAZARD OF FIRING OPEN, UNCONFINED SHOTS IN COAL MINES

By M. J. Ankeny

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INTRODUCTION

The expression "firing open, unconfined shots," as used in this circular, means the firing of explosive charges not confined in boreholes. Examples are the so-called mudcap shots, adobe or dobe shots, or bulldozing shots consisting of explosive charges placed on, under, or between rocks for the purpose of breaking them.

The practice of firing open, unconfined shots is not uncommon in coal mines, despite the fact that numerous mine explosions and dust ignitions have resulted from this practice. The usual method of preparing such shots is to place the explosive with its detonator on top of a piece of rock or coal and cover it with clay, loam, sand, or road dust; frequently no covering of any kind is used. In some mines, an open charge of explosive is placed on timbers to dislodge them or in crevices in the roof to break down loose rock that cannot be dislodged with a bar or pick. The explosive charges may be made and fired singly, although sometimes several charges are placed on one large piece of rock with a detonator in each charge, and all charges are fired simultaneously. Although it is general practice to use permissible shot-firing devices, which will not ignite gas or dust to fire these charges, electric power from the regular mine circuits is sometimes used. When the shot is fired, any coal dust that may be present is thrown into suspension by the blast and may be ignited by the intense hot flame of the explosive or by an arc or spark at the leg wires or the end of the firing leads if power from the regular mine circuit is used to fire the shot. Even if there is not enough coal dust present to form a dust cloud, open, unconfined shots can readily ignite methane.

The safest kinds of explosives for use in coal mines are permissible explosives tested and approved for such use by the Federal Bureau of Mines. But permissible explosives also are capable of igniting gas or dust unless used in proper quantities and confined in a borehole with incombustible stemming. Tests have indicated that a very small charge of permissible explosive may be fired safely in the open if covered with a large amount of rock dust or other incombustible dust, but such practice is not recommended. A charge small enough to be safe when fired in this manner would generally not be large enough to break rock.

SUMMARY

Six major disasters have been caused by the firing of open, unconfined shots of the bulldozing type during the past 24 years, according to the records

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of the Federal Bureau of Mines. This practice also has been responsible for numerous less serious gas and dust ignitions; the Bureau has on record 13 specific cases.

Disasters of this kind can be prevented by using only permissible explosives properly confined in boreholes and fired electrically by permissible blasting units.

DISASTERS CAUSED BY FIRING OPEN, UNCONFINED SHOTS

The most recent explosion of this kind occurred in the United Gas No. 1 mine of the Truax-Traer Coal Co. at Wevaco, Kanawha County, W. Va., October 31, 1951. Sixteen men were in the mine at the time of the explosion; 9 of these were killed by violence and flame, 3 were killed by the gaseous products of the explosion, and 4 escaped uninjured. The explosion was caused by ignition of coal dust near the face of a working place when at least 12 open, unconfined shots of permissible explosives were fired simultaneously on a fall of rock. Flame was propagated for 1,700 feet from the point of ignition because of the inadequacy of rock dust in the affected area. The analytical results of air samples taken during previous Federal inspections of the mine did not indicate methane, and there was no record of methane having been detected with a flame safety lamp. Moreover, there was no evidence that explosive gas could have been involved in this explosion. The ratio of volatile matter to total combustible matter of the coal, which is an index to its explosivility, is 0.365. Experiments conducted by the Bureau of Mines have shown that dust from coal having a ratio of volatile matter to total combustible matter of 0.12 may be exploded, and that the explosibility increases as the ratio increases. The firing of the 12 or more charges of explosives raised a dust cloud, which was ignited by the flame of the explosive or by an arc at the detonator leg wires or firing leads.

A coal-dust explosion occurred in the No. 9 Havaco mine, New River & Pocahantas Consolidated Coal Co., Havaco, McDowell County, W. Va., at 9:35 a.m., January 15, 1946. Two hundred and seventy men were in the mine at the time of the explosion. Of this number, 234 escaped to the surface unaided, 24 were injured and had to be rescued, 12 were killed outright, and 3 died later in the hospital.

The explosion originated 640 feet from the main intake air shaft on one of the main intake airways, which contained the main empty track. It was caused by firing an unconfined and overloaded charge of dynamite placed in a crevice between a piece of loose roof rock and the main roof. The mine was well rock-dusted in dry areas; but large quantities of fine float dust, principally from hoisting and dumping, were deposited in the vicinity of the coal-hoisting shaft and extended along the haulageways and adjacent intake airways for several hundred feet. The explosion failed to reach the working section of the mine because of ample rock dust in the entries leading thereto, but it killed or injured everyone within a radius of 1,000 feet of the shaft bottom.

Before this explosion it was believed by some that the dust in this mine was nonexplosive because of the low volatile content of the coal. The volatile content of the coal was 15 percent, and the ratio of the volatile matter to the total combustible matter of the coal was 0.163.

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A coal-dust explosion occurred in the Keen Mountain mine, Red Jacket Coal Corp., Hanger, Buchannan County, Va., at about 4:45 p.m., April 22, 1938, shortly after the night shift had entered the mine. This explosion resulted in the death of 45 men and the injury of 2 others. All of the men who were in the section in which the explosion occurred were killed, and three men were killed on the outside of the mine by forces coming out the drift mouth.

This explosion was caused by the simultaneous firing of three adobe or bulldozing shots in the face of an entry. The shots were fired with 250-volt direct current from the drill cable and were believed to have contained six sticks of lump coal "C" permissible explosive and three No. 6 electric detonators.

Methane had never been found in the mine before the explosion, and only traces were found during the investigation. The ratio of volatile matter to total combustible matter of the coal was 0.235, and the mine was dry and dusty. Rock dust had been applied in the mine sparsely by hand. Dust samples collected in the explosion area following the explosion contained 10.6 to 30.5 percent incombustible matter, which was far below the quantity of inert matter necessary to prevent ignition of the dust and propagation of flame.

In this case, firing the bulldozing shot raised a dust cloud into the air, and the dust was ignited either by the flame from the explosives or an electric arc at the end of the firing cable or leg wires. The explosion was propagated throughout most of the mine by coal dust.

A coal-dust explosion occurred in the No. 30 mine of the Black Mountain Corp. at Kenvir, Ky., May 22, 1928, resulting in the death of eight men, one of whom died from the effects of breathing afterdamp while assisting with the recovery work. The explosion was caused by firing two charges of 40-percent dynamite placed about 10 feet apart on a large piece of slate. Cap and fuse were used to detonate the charges, and it is believed that, when the first charge exploded it raised a cloud of coal dust into the air, which was ignited by the flame produced by the second charge.

A coal-dust explosion occurred in the McAlpin mine of the McAlpin Coal Co., McAlpin, W. Va., October 22, 1928. Two hundred men were in the mine at the time of the explosion, but only 22 were working in the section affected by the explosion. Of these 22 men, 6 were killed, and 16 escaped with the aid of a rescue party. The explosion was caused by firing an open, unconfined shot of 10 sticks of 16-percent dynamite on a piece of sandrock 9 feet by 9 feet by 12 inches thick. The dynamite was detonated by cap and fuse. Analyses of dust samples collected after the explosion indicated that the average incombustilbe content of the dust was 9.5 percent. The mine had not been rock-dusted.

A coal-dust explosion occurred in mine No. 53 of the Ellsworth Collieries Corp. at Cokeburg, Pa., on April 2, 1927. Three hundred and six men were in the mine at the time of the explosion. Of this number six were killed, five were injured or gassed, and two who were immediately outby the area covered by the flame escaped with scratches caused by flying fragments of coal. The explosion was caused by firing, simultaneously, two mud-capped charges of

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40-percent dynamite consisting of two cartridges each, placed on a piece of sandstone at the face of a room. The fact that the main haulage roads and butt or room entries were rock-dusted to the ends of the trolley wire probably saved the lives of a great many men.

In addition to these six major disasters, numerous gas and dust ignitions of a less serious nature have occurred from firing open, unconfined shots. The Bureau of Mines has on record at least 13 specific cases in which open, unconfined shots have started explosions, which failed to propagate widely.

RECOMMENDATIONS

Explosions such as those described in this report are avoidable. They may be prevented by observing four simple precautions, as follows:

1. No explosives, other than permissible explosives, should be used for blasting in underground coal mines.

2. All explosive charges should be properly confined in boreholes before being fired.

3. Explosives should be confined in boreholes by incombustible stemming, such as clay, rock dust, or sand.

4. All shots should be fired electrically by means of permissible shot-firing units.

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